ANALYSIS OF SOYBEAN SHIPMENTS AT U.S. ORIGIN AND OVERSEAS DESTINATION

UNITED STATES DEPARTMENT OF AGRICULTURE

MARKETING RESEARCH REPORT NUMBER 1090

PREPARED BY SCIENCE AND EDUCATION ADMINISTRATION

On January 24, 1978, four USDA agencies--Agricultural Research Service (ARS), Cooperative State Research Service (CSRS), Extension Service (ES), and the National Agricultural Library (NAL)--merged to become a new organization, the Science and Education Administration (SEA), U.S. Department of Agriculture.

This publication was prepared by the Science and Education Administration's Federal Research staff, which was formerly the Agricultural Research Service.

ACKNOWLEDGMENTS

This research was made possible through the efforts and contributions of numerous individuals and organizations. Valuable assistance and support for this work were received from the American Soybean Association and the U.S. Department of Agriculture's Foreign Agricultural Service. Many grain shippers, receivers, and carriers made their shipments, facilities, and equipment available for the study.

USDA's Federal Grain Inspection Service, a cooperator in this project, contributed substantially to this study both in developing the project and in sampling at the U.S. export elevators and at several overseas destinations. Research associates William A. Bailey, William L. Craig, and William G. Kindya collected some of the origin samples and Roy E. McDonald, Lawrence A. Risse, Anton J. Bongers, and Ben M. Hillebrand some of the destination samples. E. James Koch provided advice on sampling and data processing of the test results.

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Washington, D.C.

Issued June 1978

ANALYSIS OF SOYBEAN SHIPMENTS AT U.S. ORIGIN AND OVERSEAS DESTINATION

By C. J. Nicholas and M. E. Whitten 1/

ABSTRACT

This is an interim report to determine whether there are grade and quality differences in soybean shipments between U.S. origin and overseas destination. Conditions and grade standards are compared and other factors affecting the availability and suitability of U.S. soybeans are identified. This study quantifies the extent of soybean damage, with suggestions for its reduction. It describes specific handling and transport environments and operations that cause losses as soybeans are moved through the various marketing channels. Increasing demands by industry for this type of information prompted this study.

Ten soybean shipments with 767 origin and 428 destination samples were found to be highly variable. The foreign material and the splits, or broken beans, were within the U.S. standards for grade 2 soybeans at both origin and destination. The data show an increase in foreign material and splits as the soybeans were moved from U.S. ports to overseas buyers.

The foreign material variations may have been due to in-transit deterioration or to grading or sampling errors, or they may have been the natural result of sampling variations. Although the amount of foreign material in the shipments did not exceed the grade standards, more samples are needed to determine the amount at the export elevator, based on various sampling methods and modes of transport.

The quality analyses of origin and destination samples were surprisingly similar for oil and protein content, averaging 20.7 percent of oil at origin and destination and 40.3 and 40.2 percent of protein at origin and destination, respectively.

Gravity activated loading systems for moving soybeans caused less impact damage than pneumatic unloading systems. Overseas handling and unloading systems, including clam buckets, pneumatic suckers, and Vac-u-vators, damaged the soybeans when they were moved from the ship to the processor or end user.

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Charter rates to move 10 shipments to overseas destination were lower than conference rates because supply and demand were favorable in both the soybean and the shipping market.

Soybean prices during this period were variable, with no apparent relationship to quality.

INTRODUCTION

Soybeans are a major source of protein in the diets of a large segment of the world population and one of the principal U.S. exports for cash sales abroad. Therefore, improving handling and transport of this product to world markets and reducing the distribution costs are of great importance to the U.S. grower, shipper, and overseas consumer. Failure to achieve these goals will result in needless waste of this vital source of food and will jeopardize the overseas market for U.S. farmers, with greater deterioration in transit and increased costs in handling, transport, and processing.

Complaints by European and Far Eastern buyers about quality of U.S. soybeans have centered on the problems of grade determination and alleged increases in foreign materials and splits, 2/ or broken beans. Also, questions have been raised on the amount of oil and protein in U.S. soybeans. Although foreign buyers have expressed concern about soybean damage and deterioration, neither the extent nor the causes have been documented. There has been no followup research to develop, evaluate, and demonstrate improved facilities, equipment, and techniques for handling and transport of this important commodity of American agriculture.

The increasing importance of Brazil as a world supplier of soybeans is well known. Its production increased from about 1 million tons in 1969 to an estimated 11.6 million tons in 1976, with an increase in exports from about 318,000 tons in 1969 to 3.5 million tons in 1975. Since Brazil has emerged as an important soybean producer-exporter in 1969-70, the U.S. share of the soybean and soybean oil market has fallen from about 95 to less than 70 percent.

Because competition for U.S. soybeans in world markets is becoming a matter of concern, not only from production in Brazil but also from related substitutable products such as palm oil from the Far East, greater effort must be made to assure the grade and quality by solving some of the problems in handling and transport of soybeans to foreign markets. If U.S. soybeans are to continue to be a major provider of the world's protein and oil needs, improved methods must be developed to enable the U.S. supplier to ship soybeans to overseas customers under better conditions and at lower cost.

The objectives of this study are to determine the nature and extent of physical damage and quality deterioration of soybeans in handling and transit to domestic and overseas markets, where the damage occurs, and ways to reduce such physical and quality losses.

2/ Defined as soybeans with more than one-fourth broken off (U.S. Dept. Agr., Agr. Mktg. Serv. Grain Insp. Manual, p. 189, Instr. 918 (GR-6) (Aug. 1971)).

METHODOLOGY

Ten soybean shipments were sampled at various U.S. inland shipping points and at embarkation and overseas ports. The samples were analyzed for such grade factors as foreign material and splits and such quality factors as oil, protein, and free fatty acids. Differences in these factors between origin and destination were then documented.

In the United States, mechanical samplers were used at either the inland terminal or the export elevators. The grade factors were determined and recorded on inspection certificate AD-189 by U.S. grain inspectors.

Shipments were by unit-train lots of 45 and 65 cars or by river barges from U.S. inland points to embarkation ports at New Orleans, La., and Baltimore, Md. Six shipments were to Japan, one to Taiwan, and one to the Netherlands.

In Baltimore, from 40 to 100 hopper cars were unloaded at the export elevator into drop pits at rates varying from 10,000 to 50,000 bushels per hour. For barges in New Orleans, marine leg barge unloaders or pneumatic suckers were used. When unloaded, soybeans were moved by conveyor belts from the marine legs to the headhouse, where they went through automatic scales. Some soybean shipments were moved to storage silos, from which they were conveyed to a cleaning system to scalp and remove foreign material. All shipments moved in the elevator were monitored by automatic diverter-type samplers. The samples were conveyed by gravity through a seamless pipe directly to the inspection laboratory, where a federally licensed inspector determined the grade. Built into the headhouse were several shipping bins. Soybeans loaded out for export moved from the storage silos to the shipping bins. During this transfer they were weighed, sampled, and graded. These samples provided the basis for the origin samples in this report. After the grade was determined, the soybeans were moved from the shipping bins by conveyor belts and generally outloaded to the ships through downspouts, with gravity as the motive power.

Unloading procedures overseas were similar to those in the United States. In Japan, the elevators were equipped with pneumatic unloading systems. Soybeans were removed from the ship's hold with pneumatic suckers (fig. 1) or specially designed clam buckets to hoppers. The hoppers emptied them onto conveyor belts or chain-type drags, which moved them to vertical marine legs similar to those used in the United States. The beans were then weighed and spouted from the top of these legs onto conveyor belts for movement to storage.

The unloading facilities in Japan included an area for loading barges and coastwise boats. It was between the ship and the elevator docks. Some of the soybeans were immediately loaded into barges from the ship by pneumatic suckers or clam buckets without being weighed in the elevator. Weights were obtained when the barges reached their destination.

The European elevator, where shipment 8E808 was unloaded, used marine towers, which maintained a faster unloading rate. The marine tower or legs generally had two pneumatic suckers. The soybeans were elevated to a gallery

BN-46141

Figure 1.--Unloading soybeans with pneumatic suckers in Japan.

and onto conveyor belts. Some belts led to the elevators and others to a spout for delivery to barges. The beans were weighed in the gallery on the way to the storage areas and to the barges.

Because of inadequate sampling procedures and facilities at overseas elevators, alternatives had to be developed to assure that representative samples were drawn. The larger Japanese elevators were visited by a U.S. Federal grain inspector to determine where and how samples would be obtained when shipments were unloaded. Of the overseas samples, 20 percent were obtained by automatic samplers, 33 percent by ellis cups, 40 percent by grain probes, and 7 percent by pelican samplers (fig. 2). In another series of shipments, 42 percent of the overseas samples were obtained by automatic samplers, 48 percent by ellis cups, 6 percent by grain probes, and 4 percent by pelican samplers.

Samples from shipments overseas were drawn with probes by USDA researchers and grain inspectors. Arrangements are underway to temporarily install automatic samplers in three European elevators.

Any sample smaller than the total universe is subject to sampling variations. Two samples drawn by the same method may differ in several respects. The probability of obtaining a representative sample increases rapidly if the probes of the sampled soybean lot are increased, the ship is evenly loaded, and quality variations are uniformly distributed.

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Figure 2.--Drawing soybean samples from shipments in Japan: *Above*, with probe; *below*, with pelican sampler.

After origin and destination samples were drawn, they were placed in plastic bags, sealed, and sent to Washington, D.C., where they were graded by grain inspectors 3/. They were analyzed by USDA research chemists to determine the oil, moisture, and free fatty acid content, and protein analysis was provided.

When all 10 shipments were completed, information on designated grade and quality factors were analyzed for mean, minimum, and maximum amounts at a 95-percent confidence interval.

The data for the 10 shipments were obtained from 767 samples drawn during loading at origin and 428 samples drawn during unloading at destination. They provided information on grade and quality differences between origin and destination.

Since there were so many variables in handling and transport of the shipments, more samples were taken than in regular inspections in order to obtain some degree of reliability in the data.

GRADE FACTORS

Table 1 presents information on the transport, handling, and sampling of 10 soybean shipments. All ships were of the bulk carrier type and of recent construction; they flew foreign flags and were contracted for on a charter basis.

Foreign Material

The amount of foreign material was the most common complaint voiced by overseas receivers of U.S. soybeans. Over half the complaints received by U.S. shippers in 1976 pertained to foreign material. Of the 25 complaints officially documented by the Oilseeds and Products Division of the Foreign Agricultural Service in 1976, 13 were about excess foreign material. The amount found in both origin and destination samples indicated that the problem was related not only to sampling but to segregation, or natural separation of the soybeans and the foreign material in the ship's hold. During loading of soybeans, foreign material tends to collect and stratify in layers.

The segregation of the beans and the foreign material in loading and storage may explain the differences in foreign material data in table 2. For instance, the foreign material in shipment 1A109 was between 1.5 and 4.2 percent at origin and 1.7 and 6.6 percent at destination. There was a 16-percent mean increase in the foreign material for the 10 subsamples between origin and destination; 6 of these subsamples had 20-percent increases or higher.

3/ The Board of Appeals and Review is comprised of three grain inspectors, who normally determine the final grade when the grade at either origin or destination is disputed.

Table 1.--*Data on transport, handling, and sampling of 10 soybean shipments to various ports by ship and rail, 1975 crop year* 1/

Shipment No.	Soybean cargo 2/	Destination	Flag	Ship's hold			D.W.T. 3/	Speed	Rate of loading	Rate of unloading	Destination sampling	
				Amount	Depth	Length					Method	Soybean cargo
	Metric tons			*Number*	*Ft*	*Ft*	*Metric tons*	*Kn*	*Bu/h*	*Bu/h*		*Metric tons*
						By ship						
1A109-----	29,000	Japan--------	Panama-------	7	49	59	31,293	15	50,000	22,000	Ellis------	19,000
											Diverter---	3,000
2A115-----	25,000	---do--------	Singapore----	7	50	65	38,395	16.5	33,000	14,000	---do------	2,000
											Probe------	3,000
											Pelican----	15,000
3A118-----	18,000	---do--------	Liberia------	5	52	104	32,592	14.8	45,000	15,000	Probe------	8,000
4A216-----	31,000	---do--------	Switzerland--	7	50	49	32,520	15	50,000	13,000	Ellis------	10,000
											Probe------	4,000
5A220-----	32,000	---do--------	Liberia------	6	50	50	36,650	15	60,000	24,000	Diverter---	4,000
											Probe------	10,000
											Pelican----	2,000
6A411-----	8,800	Taiwan-------	Norway-------	5	49	58	28,327	15.5	50,000	7,400	Probe------	8,800
7A525-----	7,000	Japan--------	Liberia------	5	55	89	37,411	15	30,000	15,000	Diverter---	6,000
8E808-----	11,863	Netherlands--	Norway-------	8	49	64	35,700	15	50,000	15,000	Probe------	12,863
						By rail						
				Cars	Type of car							
				Number								
9T105-----	4,000	New Orleans----------		45	Hopper----------				10,000	19,000	Diverter---	4,000
10T118-----	6,500	Baltimore----------		65	---do----------				10,000	12,000	Probe------	6,500

1/ 1974 crop year for Netherlands.
2/ Some shipments did not constitute all the soybeans of a specific ship but were represented by 2 or 3 holds of a specific ship.
3/ Difference between light and loaded displacements in long tons, or cargo carrying capacity by weight.

Table 2.--*Amount of foreign material in samples from soybean shipments at U.S. origin and overseas destination, 1975-76*

Shipment No. 1/	Origin				Destination				
	Samples	Mean foreign material	95-percent confidence interval 2/	Maximum level of foreign material 3/	Samples	Mean foreign material	95-percent confidence interval 2/	Maximum level of foreign material 3/	Subsamples with over 2-percent foreign material
	Number	*Percent*	*Percent*	*Percent*	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
1A109--------	162	1.5	± 0.1	4.2	102	1.7	± 0.3	6.6	19
2A115--------	96	1.5	± .1	3.2	46	2.3	± 1.0	7.5	28
3A118--------	38	1.5	± .1	2.4	20	2.0	± .5	3.2	16
4A216--------	58	1.8	± .1	2.1	37	1.9	± .2	3.8	28
5A220--------	44	1.7	± .05	2.0	34	2.4	± .6	6.6	34
6A411--------	18	1.3	± .09	1.7	9	1.3	± .3	2.1	4
7A525--------	9	1.4	± .2	2.0	6	1.4	± .7	3.0	21
8E808--------	123	2.0	± .1	4.7	33	1.8	± .3	5.0	30
9T105--------	104	1.3	± .07	2.5	56	1.3	± .08	2.2	6
10T118--------	125	2.5	± .1	3.5	75	3.5	± .2	7.8	95

1/ Unloaded in Japan, except 6A411 in Taiwan, 8E808 in Netherlands, and 9T105 and 10T118, which were unit-train shipments.
2/ Adding or subtracting this interval gives upper and lower confidence limits.
3/ Under progressive loading plan A used by U.S. Federal Grain Inspection Service, when any 2 samples consecutively drawn exceed the grade limits, a new certificate must be issued based on the higher limits; all grade data are averaged at completion of loading, and foreign material must average 2 percent or less to come within grade 2 of U.S. standards.

The data were analyzed to determine whether segregation has any effect on the relative amount of foreign material in multiple deliveries, or deliveries at more than one overseas port, when the loading and unloading methods were similar. Figure 3 indicates an appreciable increase in foreign material in the second delivery, with less accumulation in subsequent deliveries.

Splits

Table 3 presents data on the percentage of splits in origin and destination samples. No extreme variation is indicated and the increases in splits between origin and destination samples do not follow any particular pattern. Although the damage was within the limits of the standards for grade 2 soybeans, no broad conclusions can be drawn based on only 10 shipments. However, splits have the same variability and segregation as foreign material when soybeans are moved from place to place. Foster and Holman 4/ found that 95 percent of the breakage was beans split in half and 5 percent was broken pieces of beans, which would be included in "foreign materials," according to U.S. grade standards for soybeans.

The data collected were studied to see whether there was any correlation between splits and multiple deliveries and any relationship between splits and segregation of soybeans. Figure 3 shows the percentages of splits for composite samples in three deliveries for five shipments.

Table 3 shows little change in moisture content of the beans between origin and destination. Furthermore, no consistent increase or decrease in splits was indicated during transit.

QUALITY FACTORS

Table 4 shows the amount of oil, protein, and free fatty acids in samples from seven shipments at both origin and destination. The satisfactory oil and protein content in these samples is important, because some overseas buyers have claimed that U.S. soybeans have been low in both oil and protein. The data in table 4 suggest some deterioration in oil quality as the percentage of splits increased, with a direct correlation between the quantity of splits and the quality of oil obtained in a given shipment.

HANDLING AND TRANSPORT FACILITIES

The soybeans were exposed to damage-producing hazards when they were transported from farm to country elevator by truck, to a river terminal by truck or rail hopper car, to an export elevator by river barge or rail, and in loading aboard a bulk ocean carrier for movement to final destination. Modern grain-handling methods at the various facilities, such as high velocity grain streams, pneumatic conveying, and considerable drop heights

4/ Foster, G. H., and Holman, L. E. Grain breakage caused by commercial handling methods. U.S. Dept. Agr., Mktg. Res. Rpt. 968, 23 pp. 1973.

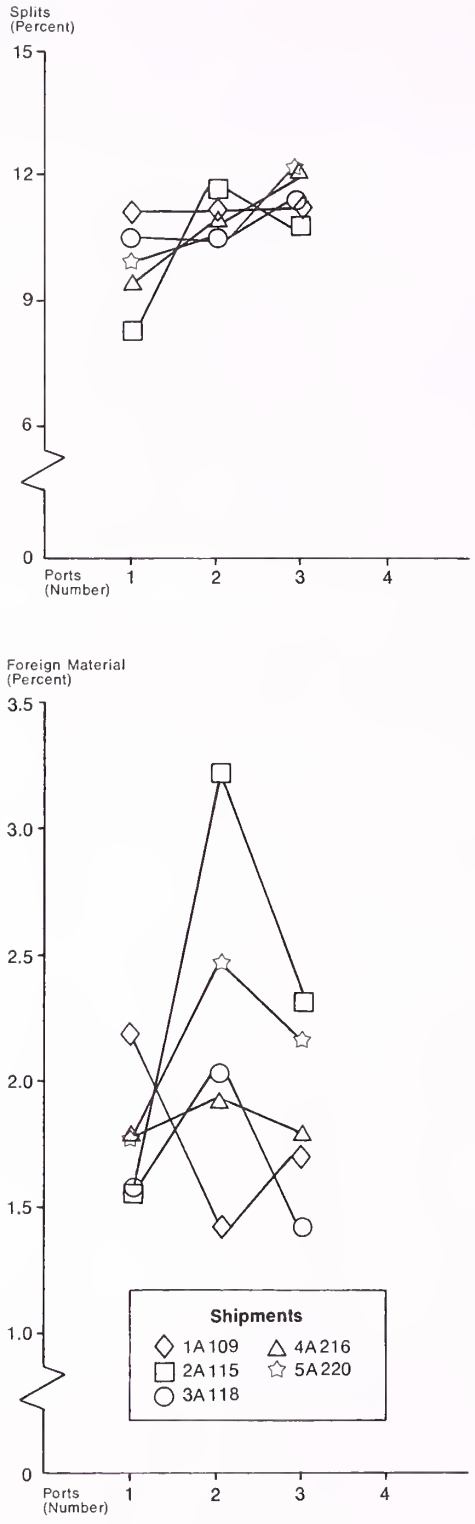

Figure 3.--Splits and foreign material in multiple deliveries of U.S. soybean shipments to different ports in Japan, 1976.

Table 3.--*Grade level 1/ of splits in samples from soybean shipments at U.S. origin and overseas destination, 1975-76*

Shipment No. 2/	Origin				Destination				Increase in splits between origin and destination
	Samples	Mean splits	95-percent confidence interval 3/	Moisture content	Samples	Mean splits	95-percent confidence interval 3/	Moisture content	
	Number	*Percent*	*Percent*	*Percent*	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
1A109--------	200	8.7	± 0.2	13.0	64	11.2	± 0.4	13.0	29
2A115--------	96	8.3	± .3	12.9	46	11.5	± 1.0	12.3	39
3A118--------	38	10.5	± .4	12.8	20	10.9	± 2.0	12.9	4
4A216--------	58	9.4	± .3	12.9	37	11.6	± 1.0	13.0	23
5A220--------	44	10.2	± .6	13.1	34	11.3	± 1.3	12.6	11
6A411--------	18	8.4	± .6	12.9	9	9.4	± .6	12.8	12
7A525--------	9	12.6	± .7	11.8	6	13.9	± .5	11.4	10
8E808--------	123	9.2	± .3	11.9	33	10.1	± .5	11.7	10
9T105--------	104	7.8	± .3	10.8	57	10.1	± .3	10.8	29
10T118--------	125	17.9	± .8	13.0	75	19.6	± .8	12.8	10

1/ Based on U.S. grade standards for soybeans.
2/ Unloaded in Japan, except 6A411 in Taiwan, 8E808 in Netherlands, and 9T105 and 10T118, which were unit-train shipments.
3/ Adding or subtracting this interval gives upper and lower confidence limits.

Table 4.--*Quality analysis of samples from soybean shipments at U.S. origin and overseas destination, 1975-76*

Shipment No. 1/	Origin				Destination			
	Oil (dry basis)	Protein (dry basis)	Free fatty acids	Splits	Oil (dry basis)	Protein (dry basis)	Free fatty acids	Splits
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1A109----------	20.8	38.33	0.5	8.53	20.7	40.66	0.5	11.21
2A115----------	20.4	41.40	.6	8.25	20.2	40.50	.9	11.45
3A118----------	21.0	41.00	.4	9.68	21.1	41.00	.6	11.33
4A216----------	20.4	40.25	.5	9.34	20.4	40.47	.5	12.10
5A220----------	20.7	40.36	.6	9.88	20.6	39.92	.5	12.13
8E808----------	20.3	40.10	.6	8.63	20.8	40.25	.6	10.12
9T105----------	21.6	40.74	.5	7.50	21.3	38.88	.4	8.11
Weighted average------	20.7	40.0	.5	----	20.7	40.2	.6	----

1/ Unloaded in Japan, except 8E808 in Netherlands and 9T105, which was a unit-train shipment.

into storage bins and ships' holds, probably caused some impact damage.5/ As shown in table 3, splits increased from 4 to 39 percent from origin to destination for the 10 shipments.

Recent improvements in handling and transport of soybeans from the farm to the export elevators have reduced this damage. For instance, hopper cars in the two unit-train shipments, with unloading from bottom hatches, are an improvement over the boxcar, which was never designed to transport bulk commodities. The boxcar is expensive to load and unload, it requires installation of grain doors, and the soybeans have to be spouted over the top of the grain doors into the car's interior. Furthermore, unloading boxcars requires "shaking the cars," which may increase impact damage to the beans.

Using hopper cars in 2 shipments, with 43 cars in 1 unit-train movement and 64 in the other, resulted in considerable savings in time and costs to the shipper, carriers, and receivers. The most apparent benefit was in reduced rates. The railroads had in effect special rates that applied to both shipments.6/ These trains moved continuously with an empty backhaul and a rapid turnaround. The loading of hopper cars averaged 10 minutes and the unloading by gravity 8 minutes. The turnaround for a hopper car in the unit train from the Middle West to the Gulf of Mexico was about 10 days, whereas the time for a hopper car in a conventional train was 30 days.

The link belt barge unloading device is a decided improvement over the clam bucket and the marine leg with cup elevators (fig. 4) used in several U.S. and overseas grain elevators. Foster and Holman found a significant reduction in breakage in bucket elevator tests.7/ More than $5 million has been invested in barge unloaders. Elevator operators report a higher rate of unloading and decreased soybean losses in loading than with previous methods and equipment.

Improvements in elevators have been made. For instance in one elevator, the movement of beans through the elevator has been increased and costs have been reduced. Sixteen loading spouts fed from three shipping belts have been replaced by four shiploaders with 35,000-bushel-per-hour shuttle belt conveyors and spouts. By extending the shiploaders from the shipping gallery over the vessel, it was not necessary to turn the ship around after partial loading to assure maximum loading.

Elevator operators in this study unanimously agreed that the gravity system used to handle soybeans in the United States caused less damage than the pneumatic suckers and Vac-u-vators used in Europe and at Far Eastern ports (figs. 1 and 5). The increased handlings and the lack of adequate handling and transport equipment overseas were responsible for the greater soybean losses there.

5/ Chung, C. J., Chung, D. S., and Converse, H. H. Damage to corn from pneumatic conveying. U.S. Dept. Agr., ARS-NC-5, 9 pp. 1973.

6/ Railroads have reflected their economies from hopper cars in their freight rates for soybeans. These rates are decidedly lower than for boxcars.

7/ See footnote 4.

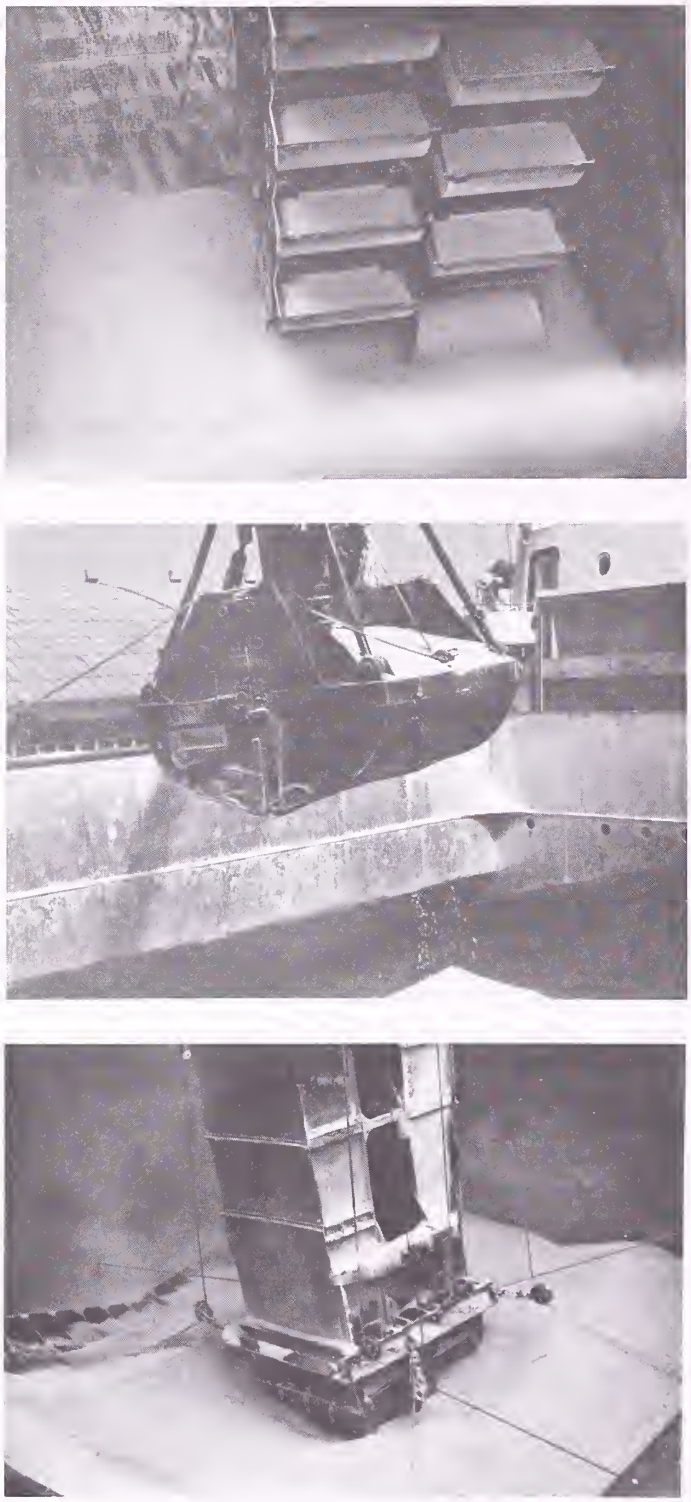

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Figure 4.--Unloading soybeans with link belt barge, clam bucket, and marine leg (cup elevators) (*top to bottom*).

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Figure 5.--Using Vac-u-vators and bagging to load soybeans in Kaohsiung, Taiwan.

Most soybean shipments move overseas in bulk carriers. They are special-type cargo ships with six to eight holds designed for moving such commodities in bulk as grain, coal, and iron ore, with gravity loading and pneumatic unloading. Tankers and "tween-deckers" are used only in extreme situations. The latter are general cargo ships with one or two decks in the holds.

The self-trimming bulk carrier, a recent innovation, was used in four of the shipments. It is relatively easy to load and unload, with no hazards to the cargo as in ships with tween-deckers, which require trimming machines, and in tankers, whose steel ladders in the holds damage the beans during loading and unloading.

Although some of these handling and transport methods could reduce in-transit damage to soybeans, economic and operational constraints may preclude their widespread use. Improved methods, such as the link belt barge unloaders, require a large outlay of capital. Unless the elevator operator is willing to make this investment, there is little opportunity to reduce this damage. Reducing the loading rate or the belt speed at the export elevators might also reduce the damage to beans, but the loading capacity of the export elevators would be so limited that their efficiency would be seriously impaired. The volume moving through the export elevators is so great and the margin of profit so small that any operational change that disturbed this relationship could have serious implications. In one large grain company, the rate of profit was reported as less than 1 cent a bushel.

TRANSPORT COSTS AND SOYBEAN PRICES

The rapid increase in soybean prices has forced buyers to consider hedging and to reduce costs in moving soybeans to their customers.

The unit-train shipments between specific points were subject to favorable special commodity rates. Shipment 9T105, a 65-hopper car movement of soybeans from Vincent, Iowa, to New Orleans, was subject to $12.50 per ton (2,000 lb); this rate applied to 5- to 80-car movements. Shipment 10T118 from Columbus, Ohio, to Baltimore cost $7.55 per ton; this was also a commodity rate applicable to at least 65-car movements.

The cost of shipping soybeans overseas fluctuated greatly during the study. Soybeans were sold on a cargo and freight basis, which includes all the costs incidental to the movement, such as stevedoring, wharfage, drayage, and storage. Table 5 shows the cargo and freight costs for U.S. soybean shipments to overseas destinations. Marine rates for soybeans, like many other bulk commodities, are granted only on the basis of cargo plus the freight charges to destination for measurement ton. The ocean transport rates for the eight shipments were voyage charter rates determined by the world market for bulk carriers and were agreed to by the buyers and the carriers involved. These conditions made for the lowest transport costs possible.

Table 5.--*Cargo and freight costs per metric ton to move U.S. soybeans to overseas destinations, 1974-75*

Shipment No. 1/	Soybean cargo cost	Freight cost	Total
1A109	$183.35	$9.00	$192.35
2A115	183.35	9.00	192.35
3A118	183.35	9.00	192.35
4A216	271.00	9.00	280.00
5A220	181.00	9.00	190.00
6A411	182.25	12.75	195.00
7A525	190.00	9.25	199.25
8E808	220.00	12.25	232.25

1/ All shipments were loaded at Gulf of Mexico ports, except shipment 8E808, which was loaded at a Great Lakes port. All destinations were Japan, except Taiwan and Netherlands for 6A411 and 8E808, respectively.

Although distance is a factor in determining rates, the major determinant in the short run is the relationship between the shipping available for soybean cargoes and the amount of soybeans to be shipped.

Voyage charter rates apply only to a single voyage. Liner charter rates agreed to by the buyer and the carrier apply to all voyages during a specified period of time. Ocean carriers of soybean cargoes are divided into liners and

tramp steamers. Liners publish rates for manufactured goods and for small quantities of bulk commodities. Their rates for large quantities of bulk commodities are termed open rates and are determined by negotiations between the ship owners and prospective shippers.

Transport of U.S. soybeans by tramp steamers under voyage charter is divided into two markets. In one market, since U.S.-flag vessels charge much higher rates than foreign-flag vessels, no direct competition exists with the foreign-flag carriers. In the other market, the rates for the foreign-flag carriers are interdependent and determined by market conditions. U.S-flag vessels compete only for 50 percent of the Government-sponsored soybean cargoes, which the Cargo Preference Act of 1954 guarantees them.

Since ships available during the study were adequate, the market for charters helped to keep the rates down. Regularly published conference rates are much higher than charter rates and not conducive to moving bulk commodities such as soybeans.

Because of the great overseas demand for U.S. grains, the capacity of the carriers was increased considerably from 13 million tons in 1960 to 145 million tons in 1975.

The use of 30,000- to 40,000-ton bulk carriers in the charter trade contributed to lower transport rates because of substantial reduction in unit costs. These unit costs included construction and maintenance, but they afforded sizable savings in operating costs. Because all the bulk carriers that transported the shipments in this study were recently constructed and highly automated, the crew costs were reduced significantly. The wage costs per ton of soybeans decreased considerably when the newer ships were placed in service. Other operating costs, such as insurance and fuel, also declined. Shipping soybeans by bulk carriers in most instances was the least costly.

Ocean rates for the 10 shipments cannot be averaged, because an average has no meaning in a constantly fluctuating market. Actual rates per ton for shipments from the United States to Europe ranged from $16.60 in 1973 to $44.50 in 1975. They were usually discussed in a range from low to high depending on the shipping season. The ocean carriers in this study had no fixed port of call.

Shipment 4A216 to Japan with a cargo and freight cost of $280 per metric ton (table 5) demonstrates the fluctuating prices of soybeans. This shipment represented a contractual commitment made by the buyer in the 1974-75 market, when the price of beans was high, and the contract was negotiated as a hedge against further price rises. During this period, ocean freight rates to Japan were averaging about $12.75 per metric ton. In the 1973-74 market, the ocean freight to Japan rose to $25 per metric ton.

Prices of soybeans during this study varied from $181 per metric ton to $271 (table 5). Attempts to quantify price-quality relationships gave meaningless results. In this study, there appeared to be no relationship between price and quality. However, this relationship may have been obscured by the grading system used and the quality factors for soybeans.

CONCLUSIONS

Analysis of data obtained from grading samples in 10 shipments at origin and destination, including splits and foreign material, showed all lots to be within the limits of the official U.S. grade standards for soybeans. However, there was a high degree of variability, which was the result of different sampling methods, in-transit deterioration, and grading or sampling errors. Insufficient samples were collected to draw valid conclusions.

Splits, a major grade variable, are objectionable to foreign buyers. However, from the data in this study, the degree to which splits are a problem is uncertain because of the limited number of samples. As with the foreign material, the amount of splits varied in certain shipments. For instance, the increase in splits between origin and destination was as high as 39 percent in one shipment (table 3). Although the amount of splits and foreign material in the shipments did not exceed that permitted by the grade standards, more data are needed, based on various sampling methods and modes of transport.

The increase in both splits and foreign material during unloading at destination indicated the effect of repeated handlings. The amount of breakage obviously tends to accumulate each time the soybeans are handled.

The gravity system used to handle and load soybeans in the United States caused less damage than the pneumatic suckers and Vac-u-vators used in unloading at ports in Europe and the Far East.

Reducing the velocity at impact would be acceptable only if the rate of movement into, through, and out of the elevators was maintained. Providing more resilient impact surfaces should be considered.

The quality analysis is favorable regarding the oil and protein content, which was satisfactory (table 4). A common complaint among foreign buyers of U.S. soybeans is the low oil and protein content. The increase in the free fatty acids in some shipments and not in others and the relationship of fatty acids to splits and foreign material require further study.

The cost data for the 10 shipments were directly related to supply and demand. During this study, soybeans were in good supply, prices were average, and shipping costs were reasonable. Soybean export prices appeared to be directly related to voyage charter rates.

As a result of this study, additional research is needed on--

(1) Identifying and verifying sources of damage, especially during loading and unloading at both export and import elevators.

(2) Engineering inputs to develop alternative systems or improvements in handling and transport of soybeans.

(3) Developing standard probe techniques to sample soybeans in ships and barges.

(4) Comparing sampling data collected by various methods and checking the accuracy or degree of error in each.

(5) Examining neutral oil contents to more accurately determine quality deterioration.

(6) Correlating grade and quality factors, such as foreign material and free fatty acids, and the foreign material and test weight with possible effects on oil content and quality.

(7) Comparing soybean prices with quality factors.

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